



## James Swartz

James H. Clark Professor in the School of Engineering and Professor of Chemical Engineering and of Bioengineering

### CONTACT INFORMATION

- **Administrator**

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### Bio

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#### BIO

Using and Understanding Cell-Free Biology

Swartz Lab General Research Focus:

The current and projected research in the Swartz lab balances basic research in microbial metabolism, protein expression, and protein folding with a strong emphasis on compelling applications. The power and versatility of cell-free methods coupled with careful evaluation and engineering of these new systems enables a whole new range of applications and scientific investigation. Fundamental research on: the mechanisms and kinetics of ribosomal function, fundamental bioenergetics, basic mechanisms of protein folding, functional genomics, and metabolic pathway analysis is motivated by a variety of near- and medium term applications spanning medicine, energy, and environmental needs.

Swartz Lab Application Focus:

In the medical area, current research addresses the need for patient-specific vaccines to treat cancer. Particularly for lymphomas, there is a strong need to be able to make a new cancer vaccine for each patient. Current technologies are not practical for this demanding task, but cell-free approaches are rapid and inexpensive. We have already demonstrated feasibility in mouse tumor challenge studies and are now expanding the range of applications and working to improve the relevant technologies. Experience with these vaccines has also suggested a new and exciting format for making inexpensive and very potent vaccines for general use.

To address pressing needs for a new and cleaner energy source, we are working towards an organism that can efficiently capture solar energy and convert it into hydrogen. The first task is to develop an oxygen tolerant hydrogenase using cell-free technology to express libraries of mutated enzymes that can be rapidly screened for improved function. Even though these are very complex enzymes, we have produced active hydrogenases with our cell-free methods. We are now perfecting the screening methods for rapid and accurate identification of improved enzymes. After these new enzymes are identified, the project will progress toward metabolic engineering and bioreactor design research to achieve the scales and economies required.

To address environmental needs, we are developing improved water filters using an amazing membrane protein, Aquaporin Z. It has the ability to reject all other chemicals and ions except water. We have efficiently expressed the protein into lipid bilayer vesicles and are now working to cast these membranes on porous supports to complete the development of a new and powerful water purification technology. The same lessons will be applied toward the development of a new class of biosensors that brings high sensitivity and selectivity.

## **ACADEMIC APPOINTMENTS**

- Professor, Chemical Engineering
- Professor, Bioengineering
- Professor, Bioengineering
- Member, Bio-X
- Member, Cardiovascular Institute
- Member, Maternal & Child Health Research Institute (MCHRI)
- Member, Stanford Cancer Institute
- Faculty Fellow, Stanford ChEM-H

## **HONORS AND AWARDS**

- Fellowship in Biochemical Engineering, Pfizer (1976)
- Florasynth Fellowship, Institute of Food Technologists (1977)
- Member, National Research Council Committee on Bioprocess Engineering (1991)
- Keynote Address, Inaugural Meeting of The American Institute of Medical and Biological Engineers (1992)
- Inducted as founding Fellow, The American Institute of Medical and Biological Engineers (1993)
- James Van Lanen Service Award, Division of Biochemical Technology, American Chem. Soc. (1993)
- Keynote Address, Asia-Pacific Biochemical Engineering Conference (1994)
- Keynote Address, Biotech (2000)
- Co-Chair, Biochemical Engineering X (1994)
- Member, National Academy of Engineering (1997)
- Opening Keynote Lecture, 2nd International Conference on Recombinant Protein Production (1999)
- Amgen Award, Society of Industrial Microbiology (2002)
- Distinguished Alumnus Award, S.Dak. School of Mines and Technology (2005)
- Elmer Gaden Award, Stanford University (2005)
- Leland T. Edwards Professor in the School of Engineering, Stanford University (2006)
- Member, National Academy of Engineering (NAE) (2006)
- Keynote Lecture, 20th Meeting for the European Society for Animal Cell Tech, Dresden, Germany (2006)
- Opening Keynote Speaker, Recent Advances in Ferm Tech (RAFT VII) (2007)
- The James Bailey Award, Soc for Biol. Eng. (Am Inst. For Chem. Eng.) (2007)
- James H. Clark Professor in the School of Engineering, Stanford University (2008)

## **BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS**

- Member, National Academy of Engineering (2013 - present)

## PROFESSIONAL EDUCATION

- PhD, Massachusetts Institute of Technolog (1978)
- ScD, MIT , Biochemical Engineering (1978)

## Teaching

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### COURSES

#### 2020-21

- Advanced Biochemical Engineering: CHEMENG 355 (Spr)
- Biochemical Engineering: BIOE 150, CHEMENG 150, CHEMENG 250 (Win)
- Graduate Practical Training: CHEMENG 299 (Sum)
- Special Topics in Protein Biotechnology: CHEMENG 500 (Aut, Win, Spr, Sum)

#### 2019-20

- Advanced Biochemical Engineering: BIOE 355, CHEMENG 355 (Spr)
- Biochemical Engineering: CHEMENG 150 (Win)
- Graduate Practical Training: CHEMENG 299 (Sum)
- Special Topics in Protein Biotechnology: CHEMENG 500 (Aut, Win, Spr, Sum)

#### 2018-19

- Biochemical Engineering: BIOE 150, CHEMENG 150 (Aut)
- Special Topics in Protein Biotechnology: CHEMENG 500 (Aut, Win, Spr, Sum)
- Synthetic Biology and Metabolic Engineering: BIOE 454, CHEMENG 454 (Spr)

#### 2017-18

- Biochemical Engineering: CHEMENG 150 (Aut)
- Special Topics in Protein Biotechnology: CHEMENG 500 (Aut, Win, Spr, Sum)
- Synthetic Biology and Metabolic Engineering: BIOE 454, CHEMENG 454 (Spr)

### STANFORD ADVISEES

#### Doctoral Dissertation Reader (AC)

Amin Aalipour, Eric Holmes, Osman Jamil, Stacie Kim, Jack Ruth, Prashanth Srinivasan

#### Postdoctoral Faculty Sponsor

Medea Neek

#### Doctoral Dissertation Advisor (AC)

Rinchu Mathew, Alex Yoshikawa

#### Doctoral (Program)

Rinchu Mathew, Andrew Yang

#### Postdoctoral Research Mentor

Medea Neek

## Publications

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### PUBLICATIONS

- **The exciting potential of modular nanoparticles for rapid development of highly effective vaccines** *Current Opinion in Chemical Engineering*  
Fogarty, J. A., Swartz, J. R.  
2018; 19: 1-8
- **Escherichia coli-based cell free production of flagellin and ordered flagellin display on virus-like particles.** *Biotechnology and bioengineering*  
Lu, Y., Welsh, J. P., Chan, W., Swartz, J. R.  
2013; 110 (8): 2073-2085
- **Cell-free co-production of an orthogonal transfer RNA activates efficient site-specific non-natural amino acid incorporation** *NUCLEIC ACIDS RESEARCH*  
Albayrak, C., Swartz, J. R.  
2013; 41 (11): 5949-5963
- **Pluripotency transcription factor Sox2 is strongly adsorbed by heparin but requires a protein transduction domain for cell internalization** *BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS*  
Albayrak, C., Yang, W. C., Swartz, J. R.  
2013; 431 (3): 641-645
- **Using E. coli-based cell-free protein synthesis to evaluate the kinetic performance of an orthogonal tRNA and aminoacyl-tRNA synthetase pair** *BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS*  
Albayrak, C., Swartz, J. R.  
2013; 431 (2): 291-295
- **Nuclear Resonance Vibrational Spectroscopy and Electron Paramagnetic Resonance Spectroscopy of Fe-57-Enriched [FeFe] Hydrogenase Indicate Stepwise Assembly of the H-Cluster** *BIOCHEMISTRY*  
Kuchenreuther, J. M., Guo, Y., Wang, H., Myers, W. K., George, S. J., Boyke, C. A., Yoda, Y., Alp, E. E., Zhao, J., Britt, R. D., Swartz, J. R., Cramer, S. P.  
2013; 52 (5): 818-826
- **Cell-free production of trimeric influenza hemagglutinin head domain proteins as vaccine antigens** *BIOTECHNOLOGY AND BIOENGINEERING*  
Welsh, J. P., Lu, Y., He, X., Greenberg, H. B., Swartz, J. R.  
2012; 109 (12): 2962-2969
- **New Insights into [FeFe] Hydrogenase Activation and Maturase Function** *PLOS ONE*  
Kuchenreuther, J. M., Britt, R. D., Swartz, J. R.  
2012; 7 (9)
- **A vaccine directed to B cells and produced by cell-free protein synthesis generates potent antilymphoma immunity** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*  
Ng, P. P., Jia, M., Patel, K. G., Brody, J. D., Swartz, J. R., Levy, S., Levy, R.  
2012; 109 (36): 14526-14531
- **Simplifying and streamlining Escherichia coli-based cell-free protein synthesis** *BIOTECHNOLOGY PROGRESS*  
Yang, W. C., Patel, K. G., Wong, H. E., Swartz, J. R.  
2012; 28 (2): 413-420
- **Generation of hydrogen from NADPH using an [FeFe] hydrogenase** *INTERNATIONAL JOURNAL OF HYDROGEN ENERGY*  
Smith, P. R., Bingham, A. S., Swartz, J. R.  
2012; 37 (3): 2977-2983
- **Evolution of an [FeFe] hydrogenase with decreased oxygen sensitivity** *INTERNATIONAL JOURNAL OF HYDROGEN ENERGY*  
Bingham, A. S., Smith, P. R., Swartz, J. R.  
2012; 37 (3): 2965-2976
- **Transforming Biochemical Engineering with Cell-Free Biology** *AICHE JOURNAL*  
Swartz, J. R.  
2012; 58 (1): 5-13

- **Solubility partner IF2 Domain I enables high yield synthesis of transducible transcription factors in Escherichia coli** *PROTEIN EXPRESSION AND PURIFICATION*  
Yang, W. C., Welsh, J. P., Lee, J., Cooke, J. P., Swartz, J. R.  
2011; 80 (1): 145-151
- **Discovery of Improved EGF Agonists Using a Novel In Vitro Screening Platform** *JOURNAL OF MOLECULAR BIOLOGY*  
Lui, B. H., Cochran, J. R., Swartz, J. R.  
2011; 413 (2): 406-415
- **A filter microplate assay for quantitative analysis of DNA binding proteins using fluorescent DNA** *ANALYTICAL BIOCHEMISTRY*  
Yang, W. C., Swartz, J. R.  
2011; 415 (2): 168-174
- **Localization of BiP to Translating Ribosomes Increases Soluble Accumulation of Secreted Eukaryotic Proteins in an Escherichia Coli Cell-Free System** *BIOTECHNOLOGY AND BIOENGINEERING*  
Welsh, J. P., Bonomo, J., Swartz, J. R.  
2011; 108 (8): 1739-1748
- **Efficient disulfide bond formation in virus-like particles** *JOURNAL OF BIOTECHNOLOGY*  
Bundy, B. C., Swartz, J. R.  
2011; 154 (4): 230-239
- **Cell-free H-cluster Synthesis and [FeFe] Hydrogenase Activation: All Five CO and CN- Ligands Derive from Tyrosine** *PLOS ONE*  
Kuchenreuther, J. M., George, S. J., Grady-Smith, C. S., Cramer, S. P., Swartz, J. R.  
2011; 6 (5)
- **Binding of a cationic protein to the cell surface is insufficient for cellular uptake and bioactivity: Arginine-rich sequences are necessary** *241st National Meeting and Exposition of the American-Chemical-Society (ACS)*  
Yang, W. C., Lee, J., Albayrak, C., Cooke, J. P., Swartz, J. R.  
AMER CHEMICAL SOC.2011
- **Surface Functionalization of Virus-Like Particles by Direct Conjugation Using Azide-Alkyne Click Chemistry** *BIOCONJUGATE CHEMISTRY*  
Patel, K. G., Swartz, J. R.  
2011; 22 (3): 376-387
- **Escherichia coli-based production of a tumor idiotype antibody fragment - tetanus toxin fragment C fusion protein vaccine for B cell lymphoma** *PROTEIN EXPRESSION AND PURIFICATION*  
Patel, K. G., Ng, P. P., Levy, S., Levy, R., Swartz, J. R.  
2011; 75 (1): 15-20
- **Development of an In Vitro Compartmentalization Screen for High-Throughput Directed Evolution of [FeFe] Hydrogenases** *PLOS ONE*  
Stapleton, J. A., Swartz, J. R.  
2010; 5 (12)
- **High-Yield Expression of Heterologous [FeFe] Hydrogenases in Escherichia coli** *PLOS ONE*  
Kuchenreuther, J. M., Grady-Smith, C. S., Bingham, A. S., George, S. J., Cramer, S. P., Swartz, J. R.  
2010; 5 (11)
- **Comparing the functional properties of the Hsp70 chaperones, DnaK and BiP** *BIOPHYSICAL CHEMISTRY*  
Bonomo, J., Welsh, J. P., Manthiram, K., Swartz, J. R.  
2010; 149 (1-2): 58-66
- **A Cell-Free Microtiter Plate Screen for Improved [FeFe] Hydrogenases** *PLOS ONE*  
Stapleton, J. A., Swartz, J. R.  
2010; 5 (5)
- **High-yield production of transducible transcription factors for non-viral modulation of gene expression**  
Yang, W. C., Welsh, J. P., Cooke, J. P., Swartz, J. R.  
AMER CHEMICAL SOC.2010

- **Cell-free incorporation of non-natural amino acids in proteins enables the production of complex protein bioconjugates**  
Patel, K. G., Swartz, J. R.  
AMER CHEMICAL SOC.2010
- **Effective site-specific incorporation of non-natural amino acids via simultaneous cell-free synthesis of the orthogonal tRNA and the product protein**  
Albayrak, C., Swartz, J. R.  
AMER CHEMICAL SOC.2010
- **Site-Specific Incorporation of p-Propargyloxyphenylalanine in a Cell-Free Environment for Direct Protein-Protein Click Conjugation** *BIOCONJUGATE CHEMISTRY*  
Bundy, B. C., Swartz, J. R.  
2010; 21 (2): 255-263
- **Cell-free production of Gaussia princeps luciferase - antibody fragment bioconjugates for ex vivo detection of tumor cells** *BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS*  
Patel, K. G., Ng, P. P., Kuo, C., Levy, S., Levy, R., Swartz, J. R.  
2009; 390 (3): 971-976
- **Cell-Free Production of Transducible Transcription Factors for Nuclear Reprogramming** *BIOTECHNOLOGY AND BIOENGINEERING*  
Yang, W. C., Patel, K. G., Lee, J., Ghebremariam, Y. T., Wong, H. E., Cooke, J. P., Swartz, J. R.  
2009; 104 (6): 1047-1058
- **Multiply mutated Gaussia luciferases provide prolonged and intense bioluminescence** *BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS*  
Welsh, J. P., Patel, K. G., Manthiram, K., Swartz, J. R.  
2009; 389 (4): 563-568
- **Novel Anti-CD19/Idiotype Bispecific Diabody Vaccine for B-Cell Lymphoma** *51st Annual Meeting and Exposition of the American-Society-of-Hematology*  
Ng, P. P., Jia, M., Virrueta, A., Patel, K., Swartz, J. R., Levy, S., Levy, R.  
AMER SOC HEMATOLOGY.2009: 1062-62
- **Tyrosine, Cysteine, and S-Adenosyl Methionine Stimulate In Vitro [FeFe] Hydrogenase Activation** *PLOS ONE*  
Kuchenreuther, J. M., Stapleton, J. A., Swartz, J. R.  
2009; 4 (10)
- **Cell-Free Synthesis of Functional Aquaporin Z in Synthetic Liposomes** *BIOTECHNOLOGY AND BIOENGINEERING*  
Hovijitra, N. T., Wu, J. J., Peaker, B., Swartz, J. R.  
2009; 104 (1): 40-49
- **Universal cell-free protein synthesis** *NATURE BIOTECHNOLOGY*  
Swartz, J. R.  
2009; 27 (8): 731-732
- **High-Level Cell-Free Synthesis Yields of Proteins Containing Site-Specific Non-Natural Amino Acids** *BIOTECHNOLOGY AND BIOENGINEERING*  
Goerke, A. R., Swartz, J. R.  
2009; 102 (2): 400-416
- **Continued Protein Synthesis at Low [ATP] and [GTP] Enables Cell Adaptation during Energy Limitation** *JOURNAL OF BACTERIOLOGY*  
Jewett, M. C., Miller, M. L., Chen, Y., Swartz, J. R.  
2009; 191 (3): 1083-1091
- **An integrated cell-free metabolic platform for protein production and synthetic biology** *MOLECULAR SYSTEMS BIOLOGY*  
Jewett, M. C., Calhoun, K. A., Voloshin, A., Wu, J. J., Swartz, J. R.  
2008; 4
- **BIOT 10-Cell-free protein synthesis of complex proteins and protein assemblies containing posttranslational modification** *236th National Meeting of the American-Chemical-Society*  
Goerke, A. R., Wu, J. J., Ebina, W., Bundy, B. C., Swartz, J. R.  
AMER CHEMICAL SOC.2008

- **BIOT 496-Activating and evolving hydrogenases for solar hydrogen production** *236th National Meeting of the American-Chemical-Society*  
Swartz, J. R., Stapleton, J. A., Kuchenreuther, J. M., Smith, P.  
AMER CHEMICAL SOC.2008
- **BIOT 143-Development of in vivo and in vitro systems for studying the expression and activation of [FeFe] hydrogenases and their required maturases** *236th National Meeting of the American-Chemical-Society*  
Kuchenreuther, J. M., Boyer, M. E., Stapleton, J. A., Swartz, J. R.  
AMER CHEMICAL SOC.2008
- **BIOT 482-Enhancing production of complex mammalian proteins using E-coli based cell-free protein synthesis** *236th National Meeting of the American-Chemical-Society*  
Welsh, J. P., Swartz, J. R., Bonomo, J.  
AMER CHEMICAL SOC.2008
- **Escherichia coli-based cell-free synthesis of virus-like particles** *BIOTECHNOLOGY AND BIOENGINEERING*  
Bundy, B. C., Franciszkowicz, M. J., Swartz, J. R.  
2008; 100 (1): 28-37
- **High yield cell-free production of integral membrane proteins without refolding or detergents** *BIOCHIMICA ET BIOPHYSICA ACTA-BIOMEMBRANES*  
Wuu, J. J., Swartz, J. R.  
2008; 1778 (5): 1237-1250
- **Cell-free metabolic engineering promotes high-level production of bioactive Gaussia princeps luciferase** *METABOLIC ENGINEERING*  
Goerke, A. R., Loening, A. M., Gambhir, S. S., Swartz, J. R.  
2008; 10 (3-4): 187-200
- **Development of cell-free protein synthesis platforms for disulfide bonded proteins** *BIOTECHNOLOGY AND BIOENGINEERING*  
Goerke, A. R., Swartz, J. R.  
2008; 99 (2): 351-367
- **Cell-free synthesis and maturation of [FeFe] hydrogenases** *BIOTECHNOLOGY AND BIOENGINEERING*  
Boyer, M. E., Stapleton, J. A., Kuchenreuther, J. M., Wang, C., Swartz, J. R.  
2008; 99 (1): 59-67
- **A sequential expression system for high-throughput functional genomic analysis** *PROTEOMICS*  
Woodrow, K. A., Swartz, J. R.  
2007; 7 (21): 3870-3879
- **BIOT 345-High yields of complex proteins with site-specific posttranslational modification using cell-free protein synthesis**  
Goerke, A. R., Wu, J. J., Ebina, W., Swartz, J. R.  
AMER CHEMICAL SOC.2007
- **BIOT 106-"Seeing the light" with cell-free protein synthesis**  
Goerke, A. R., Loening, A. M., Gambhir, S., Swartz, J. R.  
AMER CHEMICAL SOC.2007
- **Cell-free synthesis of proteins that require disulfide bonds using glucose as an energy source** *BIOTECHNOLOGY AND BIOENGINEERING*  
Knapp, K. G., Goerke, A. R., Swartz, J. R.  
2007; 97 (4): 901-908
- **Cell-free production of scFv fusion proteins: an efficient approach for personalized lymphoma vaccines** *BLOOD*  
Kanter, G., Yang, J., Voloshin, A., Levy, S., Swartz, J. R., Levy, R.  
2007; 109 (8): 3393-3399
- **Evidence for an additional disulfide reduction pathway in Escherichia coli** *JOURNAL OF BIOSCIENCE AND BIOENGINEERING*  
Knapp, K. G., Swartz, J. R.  
2007; 103 (4): 373-376
- **Energy systems for ATP regeneration in cell-free protein synthesis reactions.** *Methods in molecular biology (Clifton, N.J.)*  
Calhoun, K. A., Swartz, J. R.

2007; 375: 3-17

- **Rapid expression of functional genomic libraries** *JOURNAL OF PROTEOME RESEARCH*  
Woodrow, K. A., Airen, I. O., Swartz, J. R.  
2006; 5 (12): 3288-3300
- **BIOT 364-Expressing high yields of membrane proteins using cell-free synthesis**  
Wuu, J. J., Swartz, J. R.  
AMER CHEMICAL SOC.2006
- **BIOT 70-Avoiding mass transport limitations in hydrophobic biotransformations by efficient cell localization**  
Yancey, D. D., Robertson, C. R., Swartz, J.  
AMER CHEMICAL SOC.2006
- **BIOT 396-Escherichia coli-based cell-free protein synthesis of empty viral capsids**  
Bundy, B. C., Swartz, J. R.  
AMER CHEMICAL SOC.2006
- **BIOT 388-Extending cell-free protein synthesis to complex targets: Expression and maturation of FeFe-hydrogenases**  
Boyer, M. E., Stapleton, J. A., Kuchenreuther, J. M., Wang, C., Swartz, J. R.  
AMER CHEMICAL SOC.2006
- **BIOT 4-Developing a cell-free protein synthesis platform for producing proteins requiring disulfide bonds**  
Goerke, A. R., Knapp, K. G., Swartz, J. R.  
AMER CHEMICAL SOC.2006
- **BIOT 22-Directed evolution of oxygen-tolerant hydrogenases for photobiological hydrogen production**  
Stapleton, J. A., Boyer, M. E., Swartz, J. R.  
AMER CHEMICAL SOC.2006
- **Effects of growth rate on cell extract performance in cell-free protein synthesis** *BIOTECHNOLOGY AND BIOENGINEERING*  
Zawada, J., Swartz, J.  
2006; 94 (4): 618-624
- **Developing cell-free biology for industrial applications** *Annual Meeting of the Society-for-Industrial-Microbiology*  
Swartz, J.  
SPRINGER HEIDELBERG.2006: 476-85
- **Total amino acid stabilization during cell-free protein synthesis reactions** *JOURNAL OF BIOTECHNOLOGY*  
Calhoun, K. A., Swartz, J. R.  
2006; 123 (2): 193-203
- **Simultaneous expression and maturation of the iron-sulfur protein ferredoxin in a cell-free system** *BIOTECHNOLOGY AND BIOENGINEERING*  
Boyer, M. E., Wang, C. W., Swartz, J. R.  
2006; 94 (1): 128-138
- **Quantitative polysome analysis identifies limitations in bacterial cell-free protein synthesis** *BIOTECHNOLOGY AND BIOENGINEERING*  
Underwood, K. A., Swartz, J. R., Puglisi, J. D.  
2005; 91 (4): 425-435
- **Efficient and scalable method for scaling up cell free protein synthesis in batch mode** *BIOTECHNOLOGY AND BIOENGINEERING*  
Voloshin, A. M., Swartz, J. R.  
2005; 91 (4): 516-521
- **An economical method for cell-free protein synthesis using glucose and nucleoside monophosphates** *BIOTECHNOLOGY PROGRESS*  
Calhoun, K. A., Swartz, J. R.  
2005; 21 (4): 1146-1153
- **Energizing cell-free protein synthesis with glucose metabolism** *BIOTECHNOLOGY AND BIOENGINEERING*  
Calhoun, K. A., Swartz, J. R.



2005; 90 (5): 606-613

- **Maintaining stable amino acid concentrations during cell-free protein synthesis.** *229th National Meeting of the American-Chemical-Society (ACS)*  
Calhoun, K. A., Michel-Reydellet, N., Swartz, J. R.  
AMER CHEMICAL SOC.2005: U229-U229
- **Metabolic modeling of cell-free protein synthesis reactions.** *229th National Meeting of the American-Chemical-Society (ACS)*  
Calhoun, K. A., Varner, J., Jewett, M. C., Swartz, J. R.  
AMER CHEMICAL SOC.2005: U194-U194
- **Functional genomic analysis using in vitro protein expression and folding.** *229th National Meeting of the American-Chemical-Society (ACS)*  
Woodrow, K. A., Swartz, J. R.  
AMER CHEMICAL SOC.2005: U190-U191
- **Cell-free synthesis enables patient-specific vaccine production.** *229th National Meeting of the American-Chemical-Society (ACS)*  
Swartz, J. R., Levy, R., Kanter, G., Yang, J. H., Voloshin, A.  
AMER CHEMICAL SOC.2005: U202-U203
- **Economic cell-free protein synthesis system energized with glucose metabolism and NMPS.** *229th National Meeting of the American-Chemical-Society (ACS)*  
Calhoun, K. A., Swartz, J. R.  
AMER CHEMICAL SOC.2005: U180-U180
- **Rapid expression of vaccine proteins for B-cell lymphoma in a cell-free system** *BIOTECHNOLOGY AND BIOENGINEERING*  
Yang, J. H., Kanter, G., Voloshin, A., Michel-Reydellet, N., Velkeen, H., Levy, R., Swartz, J. R.  
2005; 89 (5): 503-511
- **Streamlining Escherichia coli S30 extract preparation for economical cell-free protein synthesis** *BIOTECHNOLOGY PROGRESS*  
Liu, D. V., Zawada, J. F., Swartz, J. R.  
2005; 21 (2): 460-465
- **Maintaining rapid growth in moderate-density Escherichia coli fermentations** *BIOTECHNOLOGY AND BIOENGINEERING*  
Zawada, J., Swartz, J.  
2005; 89 (4): 407-415
- **Increasing PCR fragment stability and protein yields in a cell-free system with genetically modified Escherichia coli extracts** *JOURNAL OF MOLECULAR MICROBIOLOGY AND BIOTECHNOLOGY*  
Michel-Reydellet, N., Woodrow, K., Swartz, J.  
2005; 9 (1): 26-34
- **A novel method for producing custom-made idiotype vaccines for lymphoma immunotherapy using a cell-free expression system.** *46th Annual Meeting of the American-Society-of-Hematology*  
Kanter, G., Yang, J. H., Voloshin, A., Swartz, J. R., Levy, R.  
AMER SOC HEMATOLOGY.2004: 395A-395A
- **Expression of active murine granulocyte-macrophage colony-stimulating factor in an Escherichia coli cell-free system** *BIOTECHNOLOGY PROGRESS*  
Yang, J. H., Kanter, G., Voloshin, A., Levy, R., Swartz, J. R.  
2004; 20 (6): 1689-1696
- **Substrate replenishment extends protein synthesis with an in vitro translation system designed to mimic the cytoplasm** *BIOTECHNOLOGY AND BIOENGINEERING*  
Jewett, M. C., Swartz, J. R.  
2004; 87 (4): 465-472
- **Amino acid stabilization for cell-free protein synthesis by modification of the Escherichia coli genome** *METABOLIC ENGINEERING*  
Michel-Reydellet, N., Calhoun, K., Swartz, J.  
2004; 6 (3): 197-203
- **Enhancing multiple disulfide bonded protein folding in a cell-free system** *BIOTECHNOLOGY AND BIOENGINEERING*  
Yin, G., Swartz, J. R.  
2004; 86 (2): 188-195

- **Mimicking the Escherichia coli cytoplasmic environment activates long-lived and efficient cell-free protein synthesis** *BIOTECHNOLOGY AND BIOENGINEERING*  
Jewett, M. C., Swartz, J. R.  
2004; 86 (1): 19-26
- **Protein expression and engineering for structural studies.** *227th National Meeting of the American-Chemical Society*  
Maynard, J., Garcia, K. C.  
AMER CHEMICAL SOC.2004: U131-U131
- **Cell-free protein synthesis platform: Ideal system for unnatural amino acid incorporation.** *227th National Meeting of the American-Chemical Society*  
Schulte, J., Swartz, J. R.  
AMER CHEMICAL SOC.2004: U129-U129
- **Toward protein glycosylation through post-translational modification from a cell-free protein synthesis system.** *227th National Meeting of the American-Chemical Society*  
Schulte, J., Swartz, J. R.  
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